

WHAT IS CLAIMED IS:

1 1. Apparatus for providing a predetermined consistent liquid mixture,
2 comprising:
3 a plurality of liquid component reservoirs, each of said reservoirs including
4 an inlet port for loading at least one of a plurality of selected liquid components into the
5 respective reservoir, and an outlet port;
6 a gas supplier configured to provide the same gas pressure within each
7 reservoir;
8 a plurality of valves individually coupled to individual reservoir outlet ports;
9 and
10 an electronic controller for repetitively sequencing the actuation of the
11 plurality of valves to discharge upon each valve actuation predetermined doses of at
12 least one selected component from the plurality of reservoirs to provide the
13 predetermined consistent liquid mixture.

1 2. The apparatus set forth in claim 1, wherein the apparatus further includes
2 a mixing assembly into which the predetermined doses of component are discharged
3 for mixing said liquid components to form the predetermined consistent
4 liquid mixture, said mixture assembly including a discharge port.

1 3. The apparatus set forth in claim 2, wherein the mixing assembly
2 includes a liquid flow measurement means.

1 4. The apparatus set forth in claim 2, wherein the mixing assembly
2 includes an inlet port for admitting a fluid for at least one of purging, cleaning and
3 flushing the mixing assembly.

1 5. The apparatus set forth in claim 2, wherein said mixing assembly
2 comprises a generally circular, planar, smear mixing substrate having a central
3 discharge aperture through said substrate.

1 6. The apparatus set forth in claim 5, wherein the reservoir outlet ports are
2 arranged in an annular array feeding into the mixing assembly near the periphery of the
3 smear mixing substrate.

1 7. The apparatus set forth in claim 3, wherein the liquid flow measurement
2 sensor senses the volume of liquid flowing from the mixing assembly discharge port.

1 8. The apparatus set forth in claim 1, wherein the liquid mixture is a slurry
2 mixture.

1 9. The apparatus set forth in claim 1, wherein the plurality of reservoirs are
2 each cylindrical members disposed in an annular array about a central longitudinal axis
3 which is aligned with the longitudinal axes of the plurality of cylindrical reservoir
4 members.

1 10. The apparatus set forth in claim 1, wherein the electronic controller
2 controls filling of the reservoirs with the selected liquid components.

1 11. The apparatus set forth in claim 1, wherein a predetermined liquid dose
2 comprises a fraction of the total volume of the reservoir containing the liquid
3 component.

1 12. The apparatus set forth in claim 1, wherein said valves are normally
2 closed valves and the electronic controller sequences the valve actuation such that the
3 valves operate with a constant open time and the number of actuations for respective
4 component reservoir valves is varied to control the relative doses from respective
5 component reservoirs for providing a predetermined ratio of liquid components in the
6 resultant liquid mixture.

1 13. The apparatus set forth in claim 1, wherein said valves are normally
2 closed valves and the electronic controller sequences the valve actuation such that the
3 respective valves have predetermined different open times to control the respective
4 doses from respective component reservoirs for providing a predetermined ratio of
5 liquid components in the resultant liquid mixture.

1 14. The apparatus set forth in claim 1, wherein said electronic controller
2 controls the predetermined component doses by sequencing the respective valve
3 activations with the same period of actuation while varying the number of actuation
4 cycles for respective component reservoir valves.

1 15. The apparatus set forth in claim 1, wherein said electronic controller
2 controls the predetermined component doses by sequencing the respective valve
3 actuators with a variable period of actuation selected for respective valves.

1 16. Apparatus for providing a precisely mixed liquid mixture according to
2 a predetermined recipe, comprising:
3 a reservoir section comprising a plurality of liquid component reservoirs
4 having a gas inlet port, a liquid component outlet port, and a liquid component inlet port;
5 a gas manifold section disposed at one end of the reservoirs and
6 connecting the individual reservoirs to a source of gas pressure;
7 a valving section disposed at an opposed end of the reservoirs, with a
8 plurality of valves coupled individually to the respective reservoir liquid component
9 outlet ports, and including valve outlets through which liquid component doses are
10 discharged;
11 a mixing section coupled to the valving section with the discharged liquid
12 component doses being directed to said mixing section; and
13 an electronic controller section for controlling the operation of the valving
14 section, with the individual valves being actuated in a repetitive sequence for
15 predetermined actuation periods to control the volume of liquid component which is
16 discharged from the respective reservoirs as repetitive doses until the predetermined
17 liquid mixture recipe is completed.

1 17. The apparatus set forth in claim 16, wherein the apparatus further
2 includes a mixing assembly into which the predetermined doses of liquid component
3 are discharged for mixing said liquid components to form the predetermined liquid
4 mixture, said mixing assembly including a discharge port.

1 18. The apparatus set forth in claim 17, wherein the mixing assembly
2 includes a liquid flow measurement means.

1 19. The apparatus set forth in claim 17, wherein the mixing assembly
2 includes an inlet port for admitting a fluid for at least one of purging, cleaning and
3 flushing the mixing assembly.

1 20. The apparatus set forth in claim 17, wherein said mixing assembly
2 comprises a generally circular, planar, smear mixing substrate having a central
3 discharge aperture through said substrate.

1 21. The apparatus set forth in claim 17, wherein the reservoir outlet ports are
2 arranged in an annular array feeding into the mixing assembly near the periphery of the
3 smear mixing substrate.

1 22. The apparatus set forth in claim 18, wherein the liquid flow measurement
2 sensor senses the volume of liquid flowing from the mixing assembly discharge port.

1 23. The apparatus set forth in claim 16, wherein the liquid mixture is a slurry
2 mixture.

1 24. The apparatus set forth in claim 16, wherein the plurality of reservoirs are
2 each cylindrical members disposed in an annular array about a central longitudinal axis
3 which is aligned with the longitudinal axes of the plurality of cylindrical reservoir
4 members.

1 25. The apparatus set forth in claim 16, wherein the electronic controller
2 controls filling of the reservoirs with selected liquid components.

1 26. The apparatus set forth in claim 16, wherein a predetermined liquid
2 dose comprises a fraction of the total volume of the reservoir containing the liquid
3 component.

1 27. The apparatus set forth in claim 16, wherein said valves are normally
2 closed valves and the electronic controller sequences the valve actuation such that the
3 valves operate with a constant open time and the number of actuations for respective
4 component reservoir valves is varied to control the relative doses from respective
5 component reservoirs for providing a predetermined ratio of liquid components in the
6 resultant liquid mixture.

1 28. The apparatus set forth in claim 16, wherein said valves are normally
2 closed valves and the electronic controller sequences the valve actuation such that the
3 respective valves have predetermined different open times to control the respective
4 doses from respective component reservoirs for providing a predetermined ratio of
5 liquid components in the resultant liquid mixture.

1 29. The apparatus set forth in claim 16, wherein said electronic controller
2 controls the predetermined component doses by sequencing the respective valve
3 activations with the same period of actuation while varying the number of actuation
4 cycles for respective component reservoir valves.

1 30. The apparatus set forth in claim 16, wherein said electronic controller
2 controls the predetermined component doses by sequencing the respective valve
3 actuations with a variable period of actuation selected for respective valves.

1 31. Method of mixing and delivering a predetermined liquid mixture according
2 to a predetermined recipe, wherein a plurality of liquid component reservoirs each have
3 a liquid component inlet port, gas pressure inlet port and regulator for maintaining the
4 same gas pressure within each of the reservoirs, and an outlet port coupled to valves
5 for outletting a precise amount of selected liquid component from respective reservoirs,
6 which method comprises:

7 filling the plurality of liquid component reservoirs with selected liquid
8 components;

9 maintaining the same gas pressure within each reservoir;

10 repetitively sequencing the actuation of said reservoir outlet valves to
11 discharge precise doses of selected liquid components from the plurality of reservoirs
12 during each valve actuation period into a liquid mixer and continuing said repetitive
13 sequencing of the valve openings until the liquid mixture recipe is complete; and
14 mixing and delivering the component doses to form the predetermined
15 liquid mixture for use at a point of use.

1 32. The method set forth in claim 31, wherein the repetitive sequencing of the
2 valve openings includes at least two repeated actuation cycles for each liquid
3 component which is to be added to the predetermined liquid mixture.

1 33. The method set forth in claim 31, wherein the repetitive sequencing of the
2 valve actuations has the same actuation period for each valve while varying the number
3 of actuation cycles for respective component reservoir valves.

1 34. The method set forth in claim 31, wherein the repetitive sequencing of the
2 valve actuations is carried out by varying the period of actuation for respective
3 component reservoir valves.

1 35. The method set forth in claim 31, wherein the liquid is a slurry which is
2 mixed and delivered at a point of use.

- 1 36. A system for producing a liquid mixture according to a predetermined
2 recipe for use at a point of use, comprising:
3 a central operations controller for determining the predetermined liquid
4 mixture recipe for use at the point of use; and
5 an apparatus capable of being located at the point of use for precisely
6 mixing a predetermined liquid mixture recipe, said apparatus comprising;
7 a plurality of liquid component reservoirs containing selected liquid
8 components, said reservoirs each including an inlet port for loading at least one of a
9 plurality selected liquid components into the respective reservoir, and an outlet port;
10 a gas supplier configured to maintain the same gas pressure within each
11 reservoir;
12 a plurality of valves individually coupled to individual reservoir outlet ports;
13 an electronic controller communicating with the central operations
14 controller, which electronic controller controls repetitively sequenced actuation of the
15 plurality of valves to discharge upon each valve actuation a precise dose of selected
16 component from one of the plurality of reservoirs to provide the predetermined liquid
17 mixture according to the recipe; and
18 a liquid component supplier including sources of selected liquid
19 components, and including valves for loading the selected liquid component into the
20 plurality of liquid components reservoirs.

